

Claims

What is claimed is:

1. A method for encoding an image sequence, the method comprising the steps of:
generating an estimate of apparent motion within the image sequence utilizing a dense
5 motion field of a portion of the image sequence, wherein the estimate comprises a plurality of
motion vectors each corresponding to an element of the dense motion field, and is generated at least
in part as a constrained function of a characterization of motion between elements of the dense
motion field and elements of one or more other portions of the image sequence; and
utilizing the estimate to perform motion compensation on at least one of the images
10 of the image sequence.

2. The method of claim 1 wherein the image sequence comprises a sequence of video frames.

3. The method of claim 1 further including the step of encoding the estimate such that the
estimate may be transmitted to decoder for use in decoding encoded versions of one or more of the
images of the sequence.

4. The method of claim 1 wherein the characterization is based on a multiscale data model
which characterizes the motion as a Markov random field (MRF).

5. The method of claim 4 wherein the multiscale data model characterizes at least one of
spatial coherence, temporal coherence and scale coherence of the dense motion field.

6. The method of claim 4 wherein the multiscale data model allows a motion vector at a
25 coarse scale to represent an average motion over a set of pixels from a given image of the sequence
to another image of the sequence.

7. The method of claim 4 wherein the multiscale model utilizes higher order potential
functions to characterize structural properties of the dense motion field, and singleton potential

functions to characterize the manner in which observations of particular types of dense motion fields affect the likelihood with which such fields occur.

8. The method of claim 1 wherein the constrained function comprises a first maximum *a posteriori* (MAP) estimation problem with a constraint on the entropy of the desired estimate.

9. The method of claim 8 wherein the generating step further includes the step of transforming the constrained function into a second MAP estimation problem having at least one parameter uniquely determined by the entropy constraint, wherein the entropy constraint is determined by an amount of bandwidth available for encoding the image sequence.

10. The method of claim 9 wherein a solution of the second MAP estimation problem minimizes a singleton potential function subject to the entropy constraint, wherein the entropy constraint is computed based on one or more higher order potential functions.

11. An apparatus for encoding an image sequence, the apparatus comprising:
a motion estimator operative to generate an estimate of apparent motion within the image sequence utilizing a dense motion field of a portion of the image sequence, wherein the estimate comprises a plurality of motion vectors each corresponding to an element of the dense motion field, and is generated at least in part as a constrained function of a characterization of motion between elements of the dense motion field and elements of one or more other portions of the image sequence; and

a motion compensator having an input coupled to an output of the motion estimator, and operative to utilize the estimate to perform motion compensation on at least one of the images of the image sequence.

12. The apparatus of claim 11 wherein the image sequence comprises a sequence of video frames.

13. The apparatus of claim 11 further including a lossless coder for encoding the estimate such that the estimate may be transmitted to decoder for use in decoding encoded versions of one or more of the images of the sequence.

5 14. The apparatus of claim 11 wherein the characterization is based on a multiscale data model which characterizes the motion as a Markov random field (MRF).

15. The apparatus of claim 14 wherein the multiscale data model characterizes at least one of spatial coherence, temporal coherence and scale coherence of the dense motion field.

10 16. The apparatus of claim 14 wherein the multiscale data model allows a motion vector at a coarse scale to represent an average motion over a set of pixels from the given image to another image of the sequence.

17. The apparatus of claim 14 wherein the multiscale model utilizes higher order potential functions to characterize structural properties of the dense motion field, and singleton potential functions to characterize the manner in which observations of particular types of dense motion fields affect the likelihood with which such fields occur.

20 18. The apparatus of claim 11 wherein the constrained function comprises a first maximum *a posteriori* (MAP) estimation problem with a constraint on the entropy of the desired estimate.

25 19. The apparatus of claim 18 wherein the motion estimator is further operative to transform the constrained function into a second MAP estimation problem having at least one parameter uniquely determined by the entropy constraint, wherein the entropy constraint is a function of an amount of bandwidth available for encoding the image sequence.

20. The apparatus of claim 19 wherein a solution of the second MAP estimation problem minimizes a singleton potential function subject to the entropy constraint, wherein the entropy constraint is computed based on one or more higher order potential functions.

5 21. A method for encoding an image sequence, the method comprising the steps of:
 generating an estimate of apparent motion within the sequence, wherein the estimate
is generated at least in part utilizing a Markov random field (MRF) model to characterize motion
between a given pixel of a motion field and one or more neighbor pixels; and
 utilizing the estimate to perform motion compensation on at least one of the images
10 of the sequence.

22. The method of claim 21 wherein the estimate comprises a plurality of motion vectors,
with each of the motion vectors corresponding to a pixel of the motion field.

23. The method of claim 21 wherein the neighbor pixels comprise at least one pixel in the
same image as the given pixel, at least one pixel in a previous image of the sequence, and at least
one pixel of a subsequent image of the sequence.

20 24. An apparatus for encoding an image sequence, the apparatus comprising:
 a motion estimator operative to generate an estimate of apparent motion within the
sequence, wherein the estimate is generated at least in part utilizing a Markov random field (MRF)
model to characterize motion between a given pixel of a motion field and one or more neighbor
pixels; and
 a motion compensator having an input coupled to an output of the motion estimator,
25 and operative to utilize the estimate to perform motion compensation on at least one of the images
of the sequence.

25. The apparatus of claim 24 wherein the estimate comprises a plurality of motion vectors,
with each of the motion vectors corresponding to a pixel of the motion field.

26. The apparatus of claim 24 wherein the neighbor pixels comprise at least one pixel in the same image as the given pixel, at least one pixel in a previous image of the sequence, and at least one pixel of a subsequent image of the sequence.

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